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The Calculation of the Twine Area of a Trawl Net

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Introduction

The correct matching of gear size to vessel horse power is an important aspect of trawl gear design. If a net is too large the vessel will not be able to tow it fast enough; if too small, the vessel may not be using all the available engine power at normal towing speed.

There are several formulae available (Reid, 1977; Robertson, 1980, Ferro, 1981) to help design nets and match them and other gear components to a particular vessel horse power. These formulae require the calculation of the twine area of the netting because it is representative of the size of the net.

A formula is given to calculate, perhaps with the aid of a pocket calculator, the twine area of a net made of nylon, polyester, twisted or braided polythene. The calculation takes no account of the twine in the knots and the formula therefore calculates a 'nominal' twine area which will be less than the total amount of twine used in manufacture.

Computer programs have been developed at the Marine Laboratory to calculate the nominal twine area and to predict the drag of a net at a range of speeds.

The Calculation of Nominal Twine Area

A detailed net drawing is required indicating the number of meshes across each panel, the twine diameter or tex for each panel, the stretched length or the number of rows along each panel and the mesh size. (See Strange 1978) on the preparation of net drawings).

It is first necessary to divide the net into simple trapezium-shaped areas of netting having only one twine size and mesh size over the whole area. Usually most panels of a net fit this description but sometimes a panel must be divided into smaller sections because the cutting rates change along one edge (for instance the wing of a net is often shaped, as shown in Figure 1(a)) or some double mesh is used as shown in Figure 1(b).

The twine area of each of these trapezium-shaped areas can be calculated from the formula

$$A = \frac{L \times D \times (N + M)}{1000} \quad \ldots\ldots\ldots\ldots (1)$$

where A = twine area (m^2)

L = stretched length of panel (m)

D = twine diameter (mm)

N = number of meshes across top of panel

M = number of meshes across foot of panel

Each of these quantities required to calculate A is discussed in turn below.

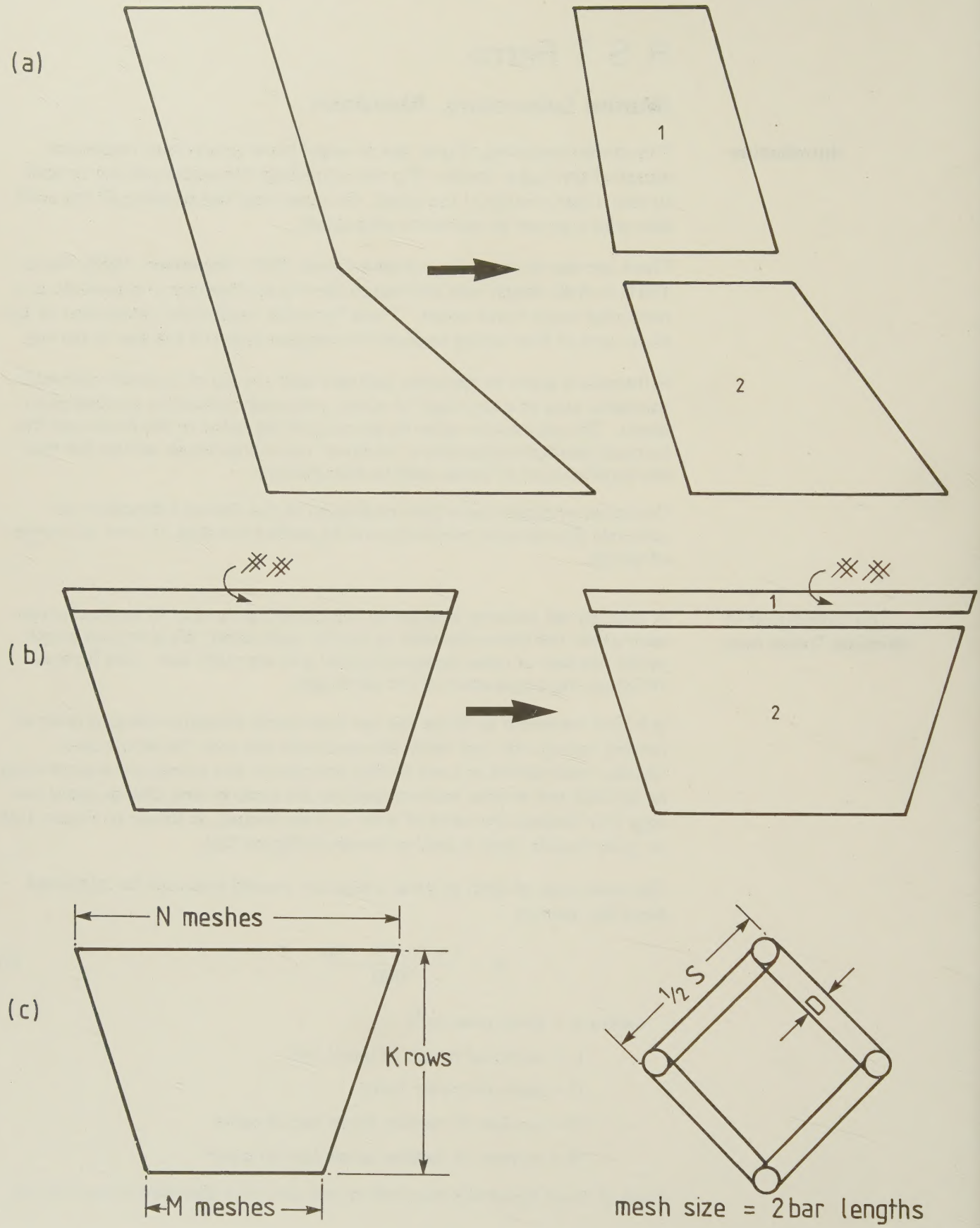

Fig. 1. Some examples of panel shapes, their division into trapezium-shaped sections and some definitions of panel parameters.

(1) Stretched length, L, in metres

The value of L must be in metres. The stretched length may be given on the net drawing directly.

Alternatively, if the number of rows are given, it may be calculated in metres from

$$L = \frac{K}{2} \times \frac{S}{N} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where K = number of rows (of knots) along panel

S = mesh size in millimetres or inches

N = 1000 if S in millimetres
or 39.37 if S in inches

It may be necessary even to work out the number of rows first from the cutting rates if no other information is given.

(2) Twine diameter, D, in millimetres

The value of D must be in millimetres. The twine diameter may be given on the net drawing directly.

Alternatively if the Tex number (g/km) or Runnage (yd/lb) or denier number for nylon twine is given, the twine diameter may be calculated in millimetres using one of the following formulae:

$$D = \sqrt{\frac{Tex}{A}} \quad \text{or} \quad \sqrt{\frac{B}{Runnage}}$$

$$\text{or} \quad \sqrt{\frac{\text{Denier x No. of Yarns}}{C}} \quad \ldots\ldots\ldots\ldots (3)$$

where D = twine diameter (mm)

Tex = Tex number (g/km)

Runnage = Runnage (yd/lb)

and Denier and No. of Yarns are quoted as eg 210/96.

The constants A, B and C are different for each twine type and are given in Table I.

Table I. Constants for Use in Twine Diameter Formula

Twine type	A	B	C
Nylon	570	870	5135
Twisted Polythene	541	917	-
Braided Polythene	321	1545	-
Polyester	667	744	-

These formulae are approximate only as the values of A, B and C are based on the measurement of the diameter of actual twines using eg a micrometer, There may be variations in the twines produced by different manufacturers

and the properties of twine may vary with use. The twine diameter used in the calculation should be that of dry unstretched twine. For more detailed information on the properties of twine see eg Klust (1973).

(3) Number of meshes across the panel, N and M

The numbers of meshes across both the forward and aft edges of the panel are required. They may be given on the net drawing. Often, however, only one of these is given and the other must then be calculated from the number of rows along the panel and the cutting rates.

Worked Example of Twine Area Calculation

Figure 2 shows a four-panel nylon net. In particular the division of the wings into trapezium-shaped areas is shown and each area of netting is given a ringed number. This is referred to in the first column of Table II, which demonstrates how the calculation can be laid out. Note that identical areas are given the same number – the number of similar areas is entered in Column 13 (see Step 4).

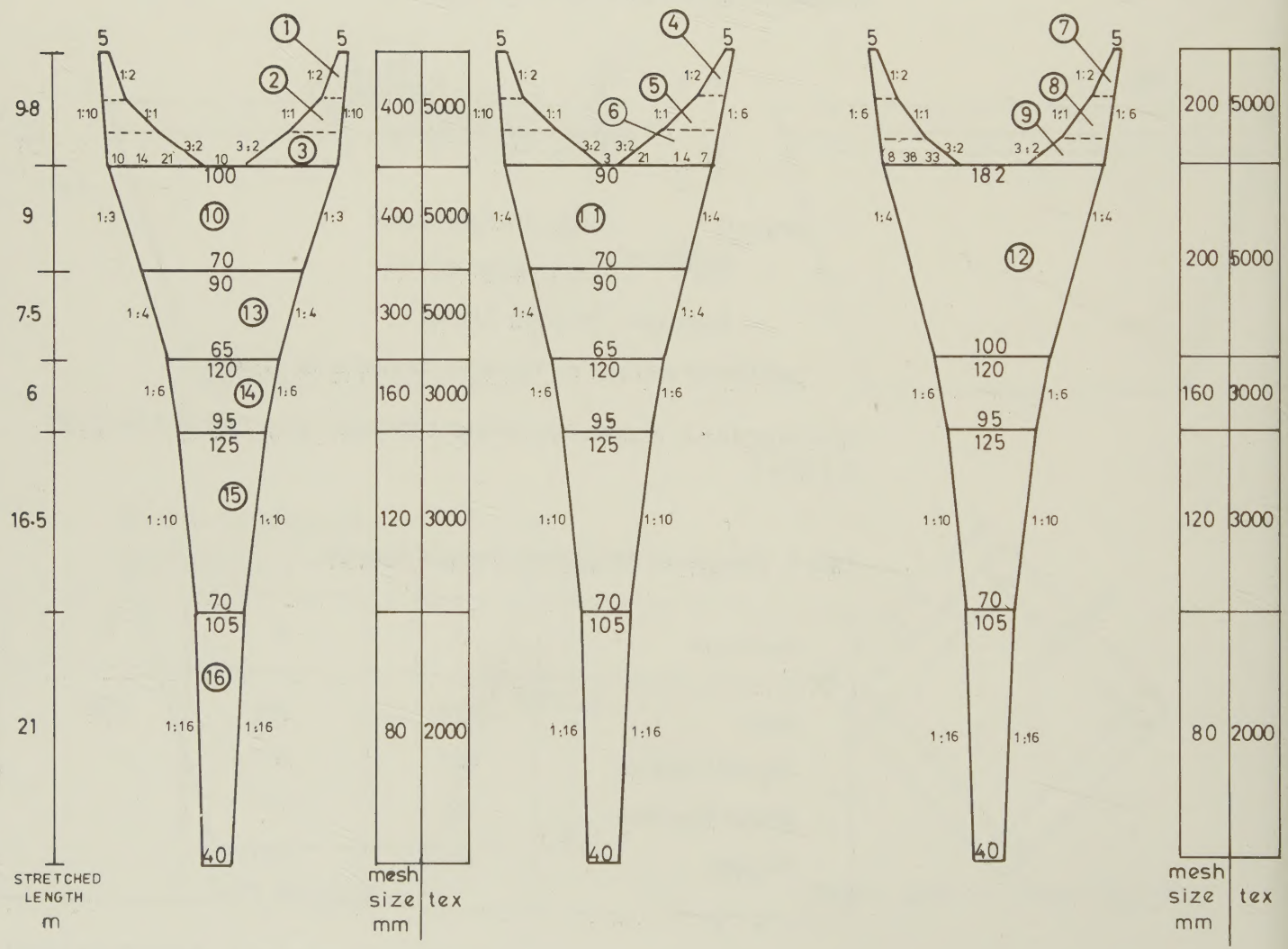

Fig. 2. Drawing of a four-panel nylon net, showing the division of the wings into trapezium-shaped areas. The circled numbers refer to the areas listed in column 1 of Table II.

Table II Layout of Calculation of the 'Nominal' Twine Area of a Net

1	2	3	4	5	6		7	8	9	10	11	12	13	14
Netting	No. of rows	Mesh Size	Stretched Length	Runnage	Denier Numbers		Tex Number	Twine Diameter	Meshes Across Top Edge	Meshes Across Bottom	N + M	Twine Area	No. of Similar Areas	n x A
Area	K	S	L	R	Denier	No. of Yarns	Tex	D	N	M		A	n	
		mm	m	yd/lb			g/km	mm				m^2		m^2
1	21	400	4.2	-	-	-	5,000	2.96	5	12.8	17.8	0.22	4	0.89
2	14	400	2.8				5,000	2.96	12.8	25.4	38.2	0.32	4	1.27
3	14	400	2.8				5,000	2.96	25.4	45	70.4	0.58	4	2.33
4	21	400	4.2				5,000	2.96	5	12.5	17.5	0.22	2	0.44
5	14	400	2.8				5,000	2.96	12.5	24	36.5	0.30	2	0.61
6	14	400	2.8				5,000	2.96	24	43	67	0.56	2	1.11
7	38	200	3.8				5,000	2.96	5	17.5	22.5	0.25	2	0.51
8	38	200	3.8				5,000	2.96	17.5	49.5	67	0.75	2	1.51
9	22	200	2.2				5,000	2.96	49.5	79	128.5	0.84	2	1.67
10	-	-	9				5,000	2.96	100	70	170	4.53	1	4.53
11	-	-	9				5,000	2.96	90	70	160	4.26	2	8.52
12	-	-	16.5				5,000	2.96	182	100	282	13.77	1	13.77
13	-	-	7.5				5,000	2.96	90	65	155	3.44	3	10.32
14	-	-	6				3,000	2.29	120	95	215	2.95	4	11.82
15	-	-	16.5				3,000	2.29	125	70	195	7.37	4	29.47
16	-	-	21				2,000	1.87	105	40	145	5.69	4	22.76
												TOTAL TWINE AREA		111.53

Step 1 If the stretched length L in metres is not shown on the drawing, columns 2 and 3 should be filled in and the value of L calculated from equation (2). The length L must be in metres.

Step 2 The twine size will be quoted in runnage, denier or tex number. The appropriate value should be entered in columns 5, 6 or 7 and the twine diameter D calculated from equation (3) in Section 2 – in this case when Tex is given the value of the constant A is 570. The twine diameter must be in millimetres.

Step 3 The number of meshes N and M across the forward and aft edges of each netting area should be put in columns 9 and 10 and added together in column 11.

Step 4 The twine area A in square metres can be calculated from equation (1) and put in column 12. To avoid writing identical rows for several identical netting areas, column 13 can be used to indicate the number of similar areas. If there is only one area of a particular type then 1 is entered in column 13. The numbers in columns 12 and 13 are multiplied together to obtain the combined twine area of all the identical areas. This is noted in column 14. Note that areas of double mesh are counted as two similar areas.

Step 5 The total twine area of the net is obtained by adding together all the numbers in column 14.

Summary A formula is given to calculate the twine area of a net made of nylon, polyester, or twisted or braided polythene. The calculation takes no account of the twine in the knots and the formula therefore calculates a 'nominal' twine area which will be less than the total amount of twine used in manufacture.

A possible layout is shown with a worked example so that the calculation may be done without the use of complex computer facilities.

References

Ferro, R.S.T. 1981. Choosing the size of Suberkrub trawl board to suit a pelagic-type four-panel trawl. *Scottish Fisheries Information Pamphlet* (6), 5 pp.

Klust, G. 1973. Netting materials for fishing gear. FAO Fishing Manual. Fishing News (Books) Ltd., 173pp.

Reid, A.J. 1977. A net drag formula for pelagic nets. *Scottish Fisheries Research Report* (7), 12pp.

Robertson, J.H.B. 1980. Some design notes for semi-pelagic or pelagic box trawls with small mesh bellies. Marine Laboratory Working Paper (80/2), 4p

Strange, E.S. 1978. A guide to the preparation of net drawings. *Scottish Fisheries Information Pamphlet* (2), 18pp.

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PREVIOUS SCOTTISH FISHERIES INFORMATION PAMPHLETS

1977	No. 1	An introduction to Commercial Fishing Gear and Methods Used in Scotland. By E.S. Strange, 34pp.
1978	No. 2	A Guide to the Preparation of Net Drawings By E.S. Strange, 18pp.
1981	No. 3	A Method for Testing the Effectiveness of Different Fishing Baits in the Sea. By A.D.F. Johnstone and A.D. Hawkins, 7pp.
1981	No. 4	Experiments on Suspended Cultivation of Mussels in Scotland. By James Mason and J. Drinkwater, 15pp.

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